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(56) Documents cited
GB 2241664 A GB 2177650 A GB 2042387 A
EP 0404350 A2 US 4625850 A

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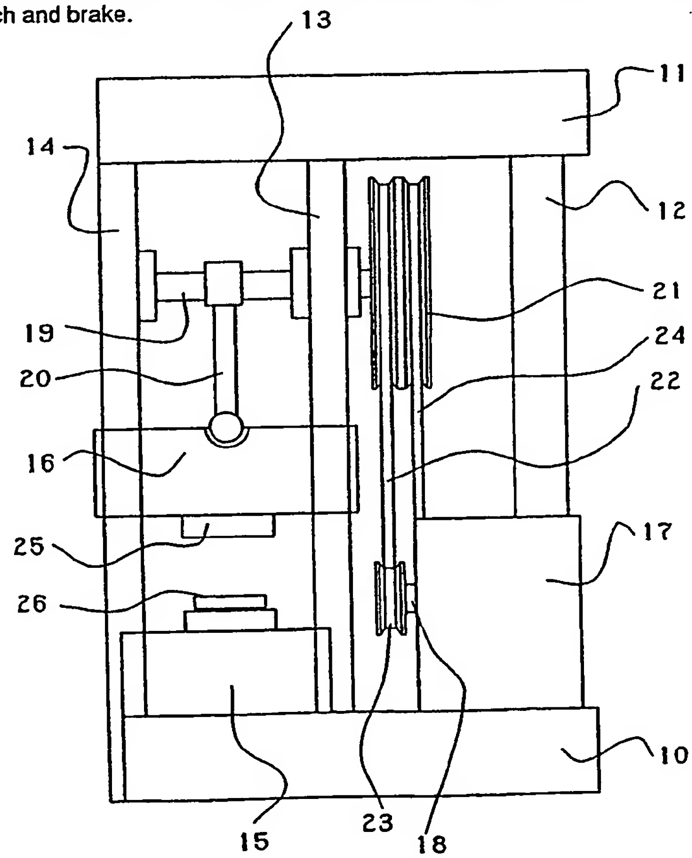
UK CL (Edition K) B5F
INT CL[5] B30B

(54) Press with positioning motor

(57) Material is worked in a press which has a positioning motor 17 for driving a movable tool 25. The motor is energised only when the tool is required to be moved. Kinetic energy is not stored in the press when the tool is not moving. The positioning motor enables the crankshaft 19 and hence the tool 25 to be brought to rest at any predetermined position and also enables the tool to be moved in small increments towards and away from a bottom tool 26. After the power stroke the motor 17 is used to brake the moving parts. Electrical energy generated by the motor during braking may be used to drive material feeding means. The motor may be microprocessor controlled. Energy is used more efficiently to work the material and there is no need for a conventional flywheel, clutch and brake.

FIG 1



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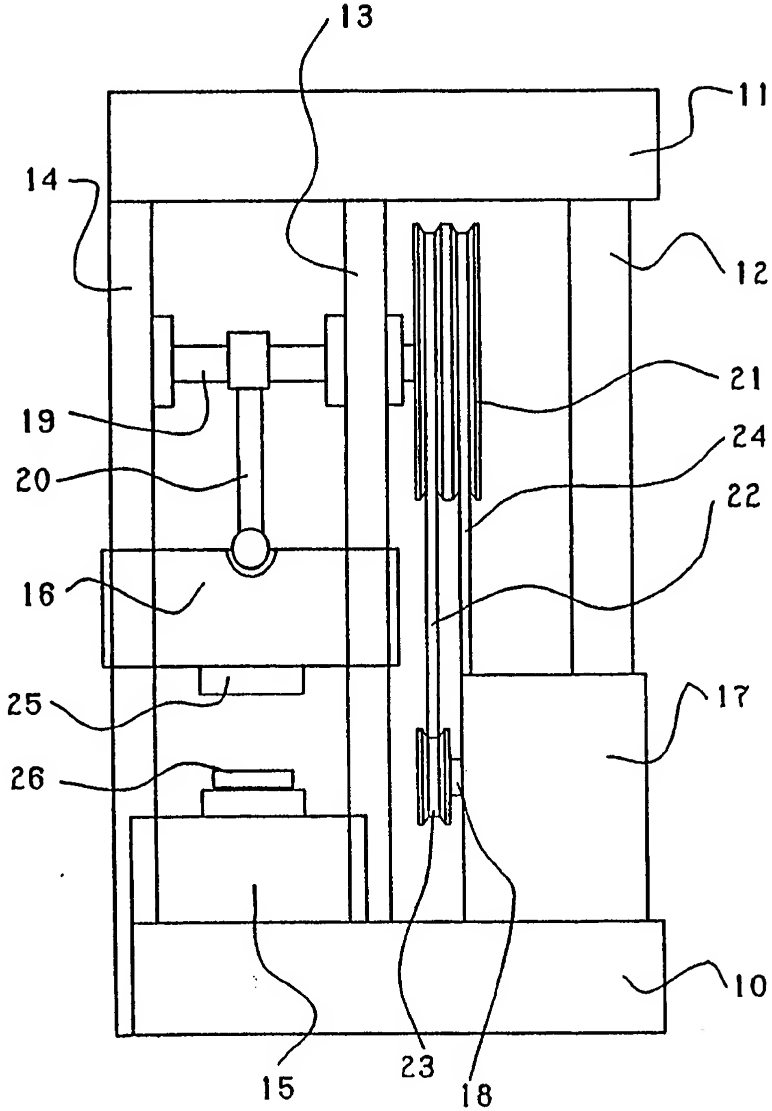
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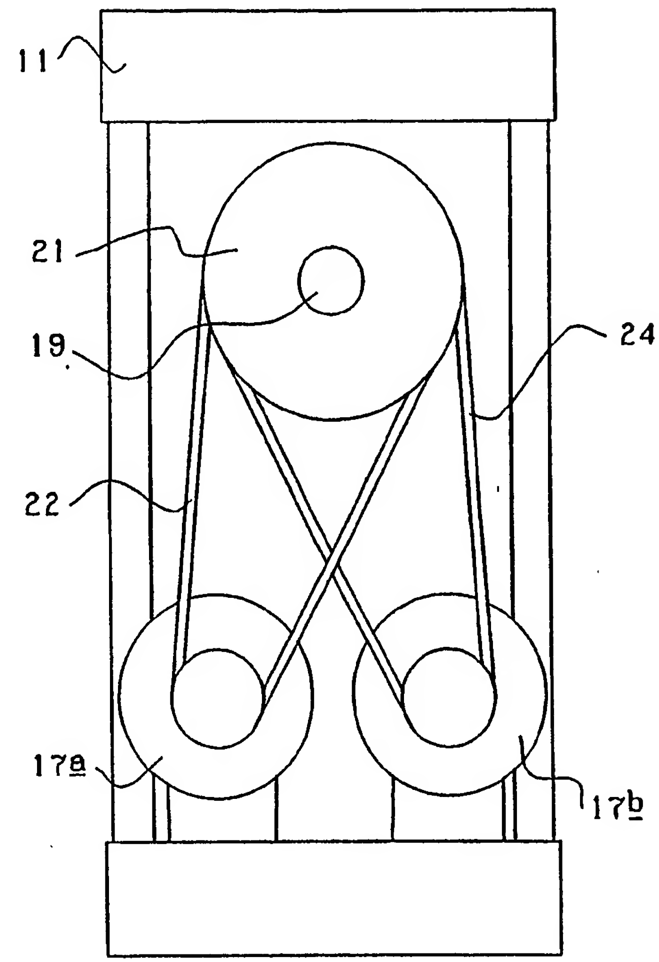
FIG 1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17a
17b

FIG 2

Title: Method of working material and press for use in the method.

<u>Description of Invention</u>

The present invention relates to working material by means of a reciprocating tool which is driven by a motor powered from a mains electricity supply or some other power source. In some cases, for example working material by means of rolls, power is supplied from the source at a generally steady rate and the power is expended continuously on working the material. In other cases, power is drawn from the power source and is accumulated in a mechanical storage device, from which energy is applied intermittently to working of the material. Examples of this latter kind of working include punching and folding, by means of a press.

A power press generally incorporates a fly wheel for storing energy. The fly wheel is rotated continuously by an electric motor. A clutch is provided for coupling the fly wheel with a tool carrier of the press when energy is to be transmitted from the fly wheel to the tool carrier. This arrangement facilitates the application of a large force to the material to be worked. However, the arrangement has a number of inherent disadvantages.

Driving of the fly wheel continuously is wasteful of energy in a case where the material is to be worked only intermittently, with a substantial interval between successive cycles of the press. The clutch is required to be a friction clutch, so that the tool carrier can be accelerated to a speed corresponding to that of the fly wheel. During the period of acceleration of the tool carrier, slip occurs at the clutch and this converts a substantial proportion of the available energy to heat. This is wasteful of energy. Furthermore, the build-up of heat at the clutch can itself be a problem and slip at the clutch inevitably gives rise to wear of the clutch plate, which must be renewed intermittently. The press must also include a brake for bringing the tool carrier to rest, once the clutch is operated to disconnect the tool carrier from the fly wheel. Use of the brake gives rise to the generation of additional heat, which is wasteful of energy, and is accompanied by

wear of the brake. Clutch and brake mechanisms of presses are noisy and are prone to failure or to inefficient operation and maintenance of these components of a press is a continual problem. Operation of the clutch and brake mechanisms of a press is inconsistent, varying according to the temperature of components of the press and therefore according to the period of continuous operation. This can lead to a need for adjustment of a press after a period of continuous operation and further adjustment after the press has been out of operation for a period.

The present invention is concerned with presses having the capacity to exert a force in excess of 10 tonnes on the material being worked. More preferably, a press and a method embodying the present invention have the capacity to exert a force in excess of 50 tonnes on the material being worked. The inherent disadvantages of known fly wheel presses are particularly significant in the case of presses with these capacities and presses of larger capacity.

The invention is also concerned with presses having the capacity to repeat an operation on material (called herein a strike) with a frequency in excess of 60 strikes per minute. In practise, a method embodying the present invention will typically involve less than 60 strikes per minute on the material being worked but there will be between successive strikes a significant interval when the tool is at rest. The time required for the press to complete one cycle will generally be less than one second and the interval between successive cycles may vary from a small fraction of a second to a period well in excess of one second, for example several seconds. More preferably, a method embodying the present invention involves reciprocating the tool through a complete cycle of movement within a period of less than one half of one second and bringing the tool to rest between each successive cycle for a rest period which may be a much smaller fraction of a second or may be a period exceeding that occupied by each cycle of movement.

According to a first aspect of the present invention, there is provided a method of working material by means of a reciprocating tool wherein the tool is guided for reciprocation towards and away from the material, energy is drawn from a power source, a major proportion of the energy drawn from the power source is imparted to the tool to establish pressure contact between the tool and

the material and to cause the tool to work the material, characterised in that said major proportion of the energy is imparted to the tool without delay and without being stored after being drawn from the source.

It will be understood that, if the tool is moved to the work, before pressure contact between the tool and the work is established, then a minor proportion of the energy drawn from the power source will inevitably be stored briefly in the tool and in other members which move when the tool is moved.

By a power source, we mean a source which is essentially extraneous to the machine which transfers energy from the source to the tool. Generally, the power source will be a mains electricity supply system.

In a preferred method, electrical energy is converted into kinetic energy by a plurality of electric motors which are energised concurrently by the power source, motion being transmitted from the electric motors collectively to the tool. Use of a number of electric motors concurrently enables the mechanical inertia of the motors and associated members to be smaller than would be the case for a single electric motor having a power output equivalent to the aggregate of the power outputs of the plurality of motors. It is desirable to restrict the mechanical inertia of the motors and associated members, in order to avoid storage of an excessive proportion of the energy derived from the power source as kinetic energy possessed by the motors and associated members.

Preferably, energy is not drawn from the power source at a substantial rate when the tool is at rest. Thus, in the preferred method, the tool is withdrawn from the material after working the material and then is held at rest and the rate at which energy is drawn from the source decreases to zero or to a very small value. It will be understood that power may be consumed at a low rate, in order to maintain a motor and parts associated therewith in a predetermined rest position. However, energy drawn from the power source to maintain members in a rest position will not be stored as kinetic energy in those members.

After the tool has worked the material, kinetic energy possessed by the tool and by parts of the press may be converted back to electrical energy, in the course of bringing the tool and these parts to rest.

Kinetic energy may be transmitted to the tool via a rotatable member which is driven cyclically. In this case, during a single cycle, the tool may be moved once to the material and then withdrawn from the material, after working the material, and the member may be turned, during the single cycle, through more than 360° in one direction and then through a smaller angle in the opposite direction.

According to a second aspect of the invention, there is provided a method of operating a power press comprising an electric driving motor, wherein energisation of the motor is substantially interrupted at the end of each cycle of operation.

According to a third aspect of the invention, there is provided a power press comprising a tool carrier, guide means for guiding the tool carrier for reciprocation, an electric motor and transmission means for transmitting motion from the motor to the tool carrier, wherein the transmission means provides a predetermined relation between the position of the tool carrier along the guide means and the position of an armature of the motor relative to a stator of the motor. The press is preferably capable of exerting a force in excess of 10 tonnes on material being worked in the press. More preferably, the press is capable of exerting a force in excess of 50 tonnes.

The invention enables a press capable of exerting a force in excess of 50 tonnes to be operated in such a manner that each complete cycle of operation occupies a period of less than one half of one second, bringing the tool carrier to rest at the end of each cycle in a predetermined position with an accuracy considerably better than that achieved with known presses having fly wheels, clutches an brakes. It is necessary to restrict the operating speed of known presses of this kind to a speed of equivalent to about 90 strikes per minute, in order that the position in which the tool carrier comes to rest will consistently be

at or near to a predetermined position, within an acceptable tolerance. This is particularly important when operation of the press must be coordinated with operation of other equipment. The present invention enables better accuracy of the stopping position to be achieved, even when the speed at which the presses operated is such that a complete cycle occupies less than one half of one second.

The press preferably comprises a plurality of electric motors having respective rotary output elements and transmission means for transmitting motion concurrently from the motors to the tool carrier, the transmission means including means for converting the rotary motion of the output element to the reciprocating motion of the tool carrier.

An example of a press embodying the third aspect of the invention and which is used in a method according to both the first and second aspects of the invention will now be described, with reference to the accompanying drawing, wherein Figure 1 shows diagrammatically a side view of the press and Figure 2 shows certain parts viewed from the rear of the press.

The press has a frame comprising a base 10, a head 11 and a number of pillars 12, 13, 14 connecting the head with the base. A bottom tool carrier 15 is mounted in a fixed position on the frame. A top tool carrier 16 is guided by the frame for reciprocation towards and away from the bottom tool carrier. In the example illustrated, the top tool carrier 16 is guided by the pillars 13 and 14 for movement along a vertical path.

A pair of electric motors 17a, 17b are provided for driving the top tool carrier 16. These motors are mounted side-by-side on the frame of the press. Transmission means is provided for transmitting movement from rotary output shafts 18 of the motors to the top tool carrier 16.

In the example illustrated, the transmission means includes a crankshaft 19 supported in bearings from the frame of the press and having a crank connected by a connecting rod 20 with the top tool carrier 16. The crankshaft is mounted with its axis perpendicular to the path of travel of the top tool carrier. On one end of the crankshaft, there is mounted a pulley 21

connected by a first toothed belt 22 with a pulley 23 on the output shaft 18 of the motor 17a and by a second toothed belt 24 with a pulley on the output shaft of the other motor. Known proximity-sensing devices may be provided for sensing the position of both belts to provide an alarm signal if either one of the belts fails. This alarm signal can be used to bring the press to rest, the position of the crankshaft and tool carrier being controlled by the motor which is still connected with the crankshaft. The use of two motors with respective drive belts ensures that the position of the tool carrier can be controlled, even if one belt fails. For this reason, even in a case where only a single drive motor is provided, this may be connected with the crankshaft by a pair of belt and pulley transmissions.

The construction and arrangement of the crankshaft 19, connecting rod 20 and tool carriers 15 and 16 may be as in known presses. The press is provided with known means for feeding through the press material which is to be worked in the press.

It will be noted that the transmission means provides positive transmission of motion from the electric motors to the top tool carrier 16. By this, we mean that continuous rotation of the rotors of the electric motors is necessarily accompanied by continuous reciprocation of the top tool carrier. There can be no slip in the transmission of movement from the motors to the tool carrier.

Each of the motors is a positioning motor. A positioning motor can be controlled electrically to turn the output shaft 18 to a predetermined position and to hold the output shaft in that position. It will be understood that the electric motors used to drive fly-wheel presses are not positioning motors. When these motors are de-energised, the position in which they come to rest is dependent upon friction, inertia and the speed at which the motor is running, when de-energised. The position in which the armature of the motor comes to rest is not necessarily reproducible, unless the rest position is defined by means extraneous to the motor. In contrast with this, the positioning motors provided in the press illustrated in the accompanying drawing will bring the crankshaft to

rest in a predetermined position. This may be selected one of a number of alternative positions in which the motor is capable of bringing the crankshaft to rest. A closed loop servo motor and stepper motor are common examples of a positioning motor.

When the press is prepared for use, a top tool 25 is mounted on the top tool carrier 16 and a bottom tool 26 is mounted on the bottom tool carrier 15. The motors 17 are capable of moving the top tool in very small increments towards and away from the bottom tool. This facilitates adjustment of the tools in the press. The motors are capable of exerting a large force on the top tool to move the top tool a small step towards the bottom tool, commencing with the top tool at rest and in a position close to the bottom tool. Thus, the action of the tools on material which is to be worked can be tested by moving the top tool in a sequence of small steps relative to the bottom tool, with an indefinite delay between successive steps.

The press is especially useful for single stroke operation, that is to say a sequence of operating cycles, each comprising a single working stroke of the top tool carrier 16 and there being between successive cycles a waiting period which typically has a duration exceeding the duration of a single cycle. In use of a known fly wheel press, single stroke working requires the clutch to be engaged at the beginning of each cycle and the brake to be applied at the end of each cycle to bring the tool carrier to rest.

In the case of the press shown in the accompanying drawing, prior to a cycle of operation, the motors 17, the pulley 21 and the crankshaft 19 are at rest. Electrical energy may be drawn from the power supply at a very low rate to maintain the armatures of the motors in predetermined positions but it will be understood that the electrical power consumed for this purpose is negligible. When material is to be worked by the tools, the motors are energised to turn the crankshaft 19 and reciprocate the top tool carrier 16. Typically, the motors will be sufficiently powerful to accelerate the crankshaft 19 to the maximum design speed within about 90° of angular movement. During this movement, the top tool

25 will normally be spaced from the material to be worked and there will therefore be no resistance to downward movement of the top tool, other than inertia. The transmission means for transmitting drive from the motors to the top tool carrier is designed to have relatively low inertia so that it can be accelerated relatively easily. Accordingly, the amount of energy which has to be expended to accelerate the moving parts of the press to the required speed is relatively small. This energy will mainly be stored in the moving parts as kinetic energy but the amount of kinetic energy stored in this way is small, as compared with the amount of kinetic energy stored in the fly wheel of a comparable fly wheel press.

Kinetic energy is stored in parts of the press shown in the accompanying drawings only during reciprocation of the tool carrier 16.

When the top tool 25 comes into engagement with the material to be worked, the material provides resistance to continued movement of the top tool carrier towards the bottom tool carrier and electrical energy must be expended at a higher rate to continue movement of the top tool and working of the material. The major part of the electrical energy expended in a complete cycle of operation is expended during working of the material and is applied immediately to the material, rather than being stored in parts of the press.

After the material has been worked by the press, the upper tool carrier 16 is moved away from the lower tool carrier 15. Since the crankshaft 19 and associated parts continue to turn at substantially the same speed as they turned as the top tool 25 moved into contact with the material to be worked, these parts, the connecting rod 20 and the top tool carrier 16 still possess kinetic energy which must be removed from them, in order to bring the parts to rest. The motors 17 are used to brake the moving parts. Preferably, the motors are used to generate electrical power which is returned to the source during braking of the moving parts of the press. Electrical energy generated by the motors 17 during braking may be used to drive feed means for feeding the material through the press.

The change from driving of the crankshaft by the motors to braking rotation of the crankshaft by means of the motors can be effected substantially

instantaneously. In a known fly wheel press, this cannot be achieved instantaneously, because it is necessary first to disengage the clutch and then to engage the brake. Typically, this involves evacuating a chamber to allow a spring to apply the brake. Typically, the motors 17 exert a substantially constant braking torque on the crankshaft until the crankshaft is brought to rest. When a friction brake is used to bring the crankshaft of a known press to rest, the braking torque will vary during deceleration of the crankshaft.

The motors 17 are controlled numerically, for example by means of a microprocessor. In a case where the top tool 25 is required to engage the material to be worked whilst the top tool carrier 16 is still near to the top of its stroke, the motors may be so controlled that the rest position of the crankshaft 19 is before the top dead centre position of the crankshaft so that, during the first part of an operating cycle, the crankshaft is turned through the top dead centre position to accelerate the top tool carrier 16 before the top tool 25 engages the material to be worked. Towards the end of the operating cycle, the crankshaft may turn through the starting position and, possibly, through the top dead centre position, before being reversed to the starting position, where the crankshaft is brought to rest.

The invention is intended to be applied to presses capable of exerting on material to be worked a force which is in excess of 10 tonne and is more advantageously applied to presses capable of exerting on the material to be worked a force in excess of 50 tonne. A force significantly less than 50 tonne may be exerted by means of a single positioning motor. Accordingly, if the press is intended to be used only for exerting forces substantially less than 50 tonne, then a single motor may be incorporated in the press. If the press is required to exert a force in the region of 100 tonne, then more than 2 positioning motors may be provided, respective output elements of all of the motors being drivingly connected with the crankshaft. It will be understood that, by means of suitable controls, numerical control of the motors, the motors can be driven together and

electrical energy will not be expended in one motor driving another motor, rather than driving the press.

It will be noted that electrical energy is expended at a significant rate only when the top tool carrier 16 is being reciprocated. This reference to the top tool carrier being reciprocated includes the instant when the crankshaft 19 is in the bottom dead centre position and the top tool carrier is at rest and includes the instant when the crankshaft is in the top dead centre position and the top tool carrier is again at rest, if the crankshaft is driven through the top dead centre position during a cycle. There is no significant expenditure of electrical energy by the press when the top tool carrier is required to be at rest, for example during feeding of material through the press or during performance of some other operation on the material.

The press does not require a clutch to initiate movement of a tool carrier and does not require a friction brake to arrest the tool carrier. However, the press may incorporate a safety brake to be used when there is no power supply available to the motor, for example during changing of tools in the press and during setting of tools. A safety brake may be of known construction, may be released by electrical energisation of the brake and may be physically mounted on or immediately adjacent to the driving motor or one of the driving motors. In a case where more than one driving motor is provided, a respective safety brake may be associated with each of these. Nevertheless, the costs associated with the maintenance of a clutch and with the maintenance of a friction brake which is used at the end of each cycle of operation are avoided.

Whilst the example of press illustrated in the accompanying drawing has a belt drive incorporated in the transmission means, it will be understood that alternative transmission means, for example a gear train or a chain and sprocket drive, may be substituted for the belt drive. The transmission means preferably provides a velocity ratio greater than unity so that the armature of each motor is turned through a complete revolution to turn the crankshaft 19 through an angle substantially less than 360°.

Since energy is transmitted directly from the motors to the top tool carrier 16, without the slip which is inherent in the use of a friction clutch, the energy is used more efficiently to work the material and there is no requirement to dissipate heat from a clutch.

The or each drive motor may be controlled in such a manner as to achieve efficient use of the electrical power available and avoid unnecessary stress of parts of the press. For example, the acceleration of the tool carrier and deceleration of the tool carrier may be selected to achieve these ends.

The use of one or more positioning motors for driving the movable tool carrier enables the position at which the tool carrier is brought to rest to be controlled with much greater precision than can be achieved consistently in known presses. This facilitates coordination of the operation of the press with operation of other equipment. The greater degree of coordination which can be achieved and the greater precision with which the press can be controlled make it possible to carry out on material which is to be processed a sequence of operations which, with known equipment, would occupy a longer period. For example, in a case where there is used a known press comprising a flywheel, clutch and brake, allowance must be made for variations in the acceleration and the deceleration of the tool carrier of the press and in the position at which the tool carrier is brought to rest. In consequence of this, it is typically necessary to include in the sequence of operations dwell periods when the equipment is at rest. Although this extends the period which is necessary to perform a particular sequence of operations, this precaution is necessary, because the operation of the press will not be exactly repeatable over a long period of use. With the present invention, substantially repeatable operation of the press is assured and therefore the press and associated equipment can be arranged to carry out a required sequence of operations in a relatively short time. Numerical or other control of a positioning motor also facilitates coordination of operation of the press with the operation of other equipment.

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS

1. A method of working material by means of a reciprocating tool wherein the tool is guided for reciprocation towards and away from the material, energy is drawn from a power source and a major proportion of the energy drawn from the power source is imparted to the tool to establish pressure contact between the tool and the material and to cause the tool to work the material, characterised in that said major proportion of the energy is imparted to the tool without delay and without being stored after being drawn from the source.

2. A method according to Claim 1 wherein the energy which is drawn from the power source is electrical energy and the electrical energy is converted into kinetic energy by an electric motor and the kinetic energy is transmitted to the tool.

3. A method according to Claim 2 wherein the electrical energy is converted into kinetic energy by a plurality of electric motors which are energised concurrently by the power source.

4. A method according to any preceding claim wherein, after working the material, the tool is withdrawn from the material and is held at rest and wherein energy is not drawn from the power source at a significant rate when the tool is at rest.

5. A method according to Claim 4, as appendant to Claim 2, wherein the electric motor has a rotary output element and motion is transmitted positively between the output element and the tool so that the tool is driven, whenever the output element of the motor is turning.

6. A method according to any preceding claim wherein, after the tool has worked the material, kinetic energy possessed by the tool is converted back to electrical energy.

7. A method according to any of Claims 2, 3 and 5, wherein, after the material has been worked by the tool, the motor exerts a substantially constant torque to brake movement of the tool.

8. A method according to any preceding claim wherein there is a substantially instantaneous change from driving of the tool to braking of the tool.

9. A method according to any preceding claim wherein kinetic energy is transmitted to the tool via a rotatable member, said member is driven cyclically, during a single cycle, the tool is moved once to the material and is then withdrawn from the material, after working the material, and wherein said member is turned during the single cycle through more than 360° in one direction and through a smaller angle in the opposite direction.

10. A method according to any one of Claims 1 to 8 wherein the period occupied by a complete cycle of movement of the tool differs substantially from the period occupied by another complete cycle of movement of the tool.

11. A method of operating a power press comprising an electrical driving motor wherein energisation of the motor is substantially interrupted at the end of each cycle of operation.

12. A power press comprising a tool carrier, guide means for guiding the tool carrier for reciprocation, an electric motor and transmission means for transmitting motion from the motor to the tool carrier, wherein the transmission means is characterised in that it provides a predetermined relation between the

position of the tool carrier along the guide means and the position of an armature of the motor relative to a stator of the motor.

13. A power press comprising a tool carrier, guide means for guiding the tool carrier for reciprocation, a plurality of electric motors having respective rotary output elements and transmission means for transmitting motion concurrently from the motors to the tool carrier, the transmission means including means for converting the rotary motion of the output elements to the reciprocating motion of the tool carrier.

14. A power press according to Claim 13 wherein the transmission means provides a positive connection between the tool carrier and the output element of each motor.

15. A method substantially as herein described of working material.

16. Any novel feature or novel combination of features described herein and/or in the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

9116429.3

Relevant Technical fields

(i) UK Cl (Edition K) B5F

(ii) Int CL (Edition 5) B30B

Search Examiner

V L C PHILLIPS

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

14 JULY 1992

Documents considered relevant following a search in respect of claims 1-10, 15

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X,E Y	GB 2241664 A (HILLTOP) whole document	1,2,4-10 3
X	GB 2177650 A (AMADA) see especially page 1 lines 112-126	1, 4
X Y	GB 2042387 A (KLAUSSNER) see especially page 1 lines 33-120	1,2,4-10 3
X Y	EP 0404350 A2 (AMP) see column 8 lines 7-25	1,2,4,5, 7-10 3
A	US 4625850 A (VERSON) whole document	

SF2(p)

SJJ - doc99\fil000137

Category	Identity of document and relevant passages	Rele .t to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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